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About the Cover

"The Real Phenomenon — A Private Moment" is a pencil drawing (22½ by 30 inches) by Linda R. Richards of the STS-7 crew, commander Robert L. Crippen, pilot Frederick H. Hauck and mission specialists John M. Fabian, Norman E. Thagard and Sally K. Ride.

When the orbiter Challenger was launched from Kennedy Space Center, Fla., on June 18, 1983, it carried the first five-person crew, including Sally Ride, the first American woman to go into space. Amidst the excitement and mass media coverage of this historic event, the STS-7 crew still managed to have individual private moments. These very personal portraits were developed by the artist, who was assigned to the pre-launch breakfast.

The NASA Art Program was instituted in 1962 with the goal of collecting a unique documentation of America's advance into space and providing a special contribution to the history of American art. Nationally known artists are invited to visit NASA sites and record their perceptions in drawings and paintings, which are then donated to the government. Each artist's personal vision of an event is conveyed in his or her particular style and becomes a part of this documentary history of the space age.

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Administrator's Column

(In this column NASA Activities features an article by NASA Administrator James M. Beggs. These articles focus on subjects chosen by him that address topics of broad interest to the agency's employees. The column this month features an address presented at the Conference on International Business in Space, held Jan. 9 in Washington, D.C.)

Space Commerce — A New Era for Industry

This is probably the world's first conference on international business in space. It certainly won't be the last, however, because commerce in space is a burgeoning new field, which many now believe will be one of the greatest growth industries of the third millennium, only 15 years away.

So this is a celebration, of sorts, and one for me personally, I might add, because it is my birthday. And around this time every year I usually recall a line by Shakespeare. It's from "Much Ado About Nothing," and goes, "When the age is in the wit is out."

That's a humbling thought, indeed, and I leave it to you to judge the truth for yourselves.

The subject of this conference, however, leaves no room for doubt. And that is the enormous potential worldwide for the commercial use of space.

Not long ago, I read in the paper that a bank — the Lamar Savings Institution in Austin, Texas — has applied to state authorities to place a branch office on the moon. Now, some may believe that to be a bit too far-sighted; but it certainly is not too far-fetched. As the Texas Savings and Loan Commissioner said after receiving the application: "Somebody's going to do it. If it makes money they're all going to do it."

Indeed they are, because whether or not the request is granted, there is a good possibility that early in the 21st century there will be a permanently manned base on the moon. That base could be the center of a new industry — mining the rich lunar resources. Or it could be a way station to other points in the solar system and serve many other functions. And it will be made possible by the Space Station we are developing now.

The lunar base might very well include not only one branch bank, but several. History has taught us that entrepreneurship and competition have been indispensable to expanding frontiers on earth. And I've no doubt they will be in space, as well.

Some call space the endless frontier. And it is, indeed, endless; because no matter how far you go, there is always further to go. This frontier offers countless new opportunities to exploit. These opportunities too are literally boundless. And we have just begun to grasp them.

Let me say at the outset that these opportunities also are very capital intensive. They require large investments and are long-term. One can expect to reap the dividends only after 15 or 20 years or so. And there are risks — financial, institutional and technological risks — all of which must be taken into account.

But we believe that those who take the plunge will have a leg up on one of the great growth opportunities of the 21st century. Folks like Newt Gingrich and Bob Walker up in the Congress predict that space commerce worldwide will be a half a trillion-dollar industry by the turn of the century. And I believe it will approximate several hundred billion dollars. But to get to that point there must be investments.

There are a number of far-sighted companies that have begun to invest in space and I'll tell you about some of the exciting new things they are doing and what we in government are doing to alleviate the risks and help them get started. I hope that our friends from abroad might find that some of the things we are doing might serve as a useful model as they prepare to expand their own activities on the commercial use of space.

There is much to learn about space. But we already know that it is no longer a completely alien and unknown frontier. In the more than quarter century we have been exploring it we have learned how to use it for our benefit on Earth.

We launch satellites, and, through them, revolutionize our communications patterns and capabilities, our Earth resources observations, our weather forecasting and our navigational techniques. We can go into space and come back pretty routinely now with the Space Shuttle. We know how to rendezvous and dock in space and how to live there for months on end. We even developed the technology to put people on other worlds, and, indeed, have done so.

Clearly, we know now that space is more than just a site for dramatic exploits, although we still have our fair share of those. We know that space can be tamed as a place for people to live and work and learn. And, step by step, we are doing that — expanding our capabilities to use its unique advantages to do new things in new ways.

The retrieval, repair and redeployment of the Solar Max satellite by our Shuttle astronauts last April and their dramatic 2.5 million-mile rescue of two errant communications satellites last November are only

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precursors of the kinds of operations that will become routine once the permanently manned Space Station is operational in the early 1990s.

What are these unique attributes of space and what do they offer us?

Space has three primary advantages.

First, it gives us a magnificent vantage point for communications and for observations of the Earth, the solar system and the universe. With only three satellites properly positioned in geostationary orbit, a person can communicate with anyone else on Earth's surface. And because there is no obscuring atmosphere in space, a telescope, such as the Hubble Space Telescope we plan to launch in 1986, will be able to see vaster reaches of the universe and objects much fainter and more distant than we can see now with Earth-based telescopes.

The second unique feature of space is zero gravity, which is zero times the acceleration of gravity. On Earth, of course, we live in a 1G environment. But in zero G, forces that inhibit many processes on Earth are not present.

Therefore, space offers opportunities for the manufacture of materials, such as pure crystals for industrial use, new medicines to help fight disease and a variety of other things with high profit potential that we simply have not imagined yet, because we are just beginning.

The third peculiarity of space is its near-perfect vacuum. Many industrial processes on Earth require a huge vacuum, which is expensive to develop. But once you're in space you get it free, because there is a near-perfect vacuum in the wake of the Shuttle and other spacecraft.

These three attributes of space — the extraordinary vantage point, zero-gravity and the infinite near-perfect vacuum — all have important commercial potential. And we are beginning to understand how to harness that potential so that industry can take advantage of it.

More than 23 years ago, it was obvious that the first of these attributes — the vantage point — was very important. Communications satellites broke the barrier for business in space when NASA launched Telstar 1, the world's first commercial communications satellite, for AT&T. Since then NASA has launched 111 communications satellites — less than half of which are now actively operating in geostationary orbit.

The communications satellite business is one of the fastest growing industries in the world, with an estimated market of more than $3 billion a year in sales potential through the year 2000.

We have not yet succeeded in using the other two unique attributes of space for commercial gain. But we are working on it.

Indeed, last January when President Reagan directed NASA to build a permanently manned Space Station within a decade, he said: "Just as the ocean opened up a new world for clipper ships and Yankee traders, space holds enormous potential for commerce today."

On July 20, the President made investment and involvement of the private sector in space a national priority. He issued a national policy on the Commercial Use of Space, which is designed to ease the entry of private investment and to reduce the bureacratic barriers that have inhibited such investments in the past.

The President said then, "We'll do all we can to ensure . . . that industry has routine access to space and a suitable reliable place to work there. And we'll do this without needless regulatory restraints." One of the first barriers to doing business in space was eliminated with a stroke of the President's pen on Oct. 30. Now, this may come as a surprise to you, but he signed legislation to ensure that products made in space by American companies would not be taxed as imports!

Other measures the Administration will focus on will provide tax credits and other tax incentives for private investment in space-based ventures. Still others will facilitate the private sector's use of radio frequencies in space, protect trade secrets and patent rights of products manufactured there and expand industry's representation on advisory panels that help to set government R&D goals.

Recently, NASA issued a statement entitled the "The Commercial Use of Space," which defines the policy initiatives and new actions we will take to expand commerce in space. We also created a high-level office, headed by an old NASA hand, Ike Gillam, to assist industry and other financial entities to finance and conduct business in space.

Our policy paper has been very well received. The Wall Street Journal called it a "Galactic Homestead Act," and indeed, it is. Just as the 19th century homesteaders earned land by taming the wild west, so, we believe, will today's space entrepreneurs help to tame the space environment by teaming up with government to expand business in space.

We will support three major initiatives. First, and most important, are new high technology ventures; second, new commercial applications of existing technology; and third, unsubsidized initiatives that would transfer existing space assets on Earth to private hands if they could be operated for profit.

We intend, in short, to reduce the technical, financial and institutional inefficiencies and impediments that have, up to now, inhibited business from going into space.

On the technical side, we will support business in a

number of ways. We will open our eight research centers around the country and encourage industry, including non-aerospace industries, to use them. Our engineers and scientists will be available for discussions with their industry counterparts. We plan also to establish scheduled flight opportunities on the Shuttle for commercial payloads, and support development of our facilities for commercial space ventures.

To reduce financial risks, we will continue to offer the Joint Endeavor Agreement, which allows NASA to offer free transportation into space for industry-sponsored experiments with promising commercial potential. As long as industry continues to fly with us, we will protect the proprietary nature of their experiments.

To reduce institutional risks, we are trying our best to make it easy to get on board the Shuttle — in a short time and without the drawn-out procedural reviews we have had in the past. We will try to assure integration and flight of a standard commercial payload no later than six months from the time we begin to process it. And we plan to shorten that period as we build up experience in flying those payloads.

So, as you can see, this is no passive program. We are serious and we intend to make it work.

Let me give you a few examples of some of the extremely promising ventures already underway.

The first is one I talk about all the time and it is very exciting. And that is the continuous flow electrophoresis apparatus being flown by Johnson & Johnson Co. and McDonnell Douglas. The electrophoresis technique has been used for years on Earth. It is a means of separating very pure quantities of biological material from a biological mass.

McDonnell Douglas Electrophoresis Operations in Space device installed in the middeck of orbiter Challenger.

It works well on Earth, but not near as well as it works in space, where it separates the material out hundreds of times faster and with much greater purity than it does here on Earth.

After clinical tests and FDA approval, the companies plan to begin production of their product in 1987 aboard a free-flying space platform to be serviced by the Shuttle.

The sponsors have invested many millions of dollars in this venture and will say only that their product is a life-saving hormone, which they are confident will be a commercial success. The first electrophoresis experiment was flown aboard Skylab back in the early 1970s. Assuming that the companies will be marketing the product by the late 1980s, which is their goal, we can see that any potentially successful commercial endeavor in space, as I said earlier, requires commitment for the long haul.

Other companies are following in the wake of these pharmaceutical pioneers.

We have an agreement with the John Deere Co., the farm implement firm. They are exploring ways of developing new alloys and new crystalline structures in space and believe they will be successful. The idea here is not to manufacture these products in space on a large scale, but to develop samples, if you will, that might be duplicated on Earth.

We also have an agreement with 3M. They are interested in developing organic crystals and thin films in space. Both have very important applications on Earth. The company has submitted a proposal to us that would allow it to fly 72 experiments on the Shuttle by 1992, and eventually to move into the Space Station. We are going to consider their proposal very seriously and I think we probably will approve it.

Very soon, the first products made in space will go on sale. They are called monodisperse latex spheres. Each is incredibly tiny — about 10 micrometers in diameter — and all are the same size. A vial of 15 million of these spheres is as big as my index finger. They have been certified by the Bureau of Standards and will be marketed by a small company in northern New Jersey.

The company believes the spheres have an annual market potential of $200 million to $300 million in the world calibration industry market alone. But that potential could increase to perhaps a billion-dollar industry because they can also be used to monitor air pollution particles, and such finely ground products as paint pigments, ink or explosives; or in such medical applications as counting red blood cells.

We are also encouraging private sector initiatives in a host of other space-based services, including launchers,

upper stage rockets and in ground-based services, such as Shuttle payload integration.

As we look to the future, we believe that our friends in Europe, Canada and Japan will accept President Reagan's invitation not only to join us in developing the Space Station, but in operating it as well.

This will be a great opportunity for all of us in the Free World to make the investments on the public side that are so necessary to spur investments from the private sector. For developed and developing countries alike, space is not only an endless frontier for exploration, but a potentially rich arena for profitable commerce to benefit all mankind.

More than 350 years ago, the Pilgrams were readying themselves for their great voyage to America. There were those who wavered, however, because they feared the dangers of the unknown. William Bradford, who chronicled their adventure, gave us an idea of how their apprehensions were dealt with in his journal. He wrote:

"It was answered that all great and honorable actions are accompanied with great difficulties and must be both enterprised and overcome with answerable courage. It was granted that the dangers were great but not desperate; the difficulties were many, but not invincible."

And so it is in our efforts to expand the realm of commerce in space. The difficulties are great, indeed. But they are not invincible. And for our part, the United States stands ready to move forward, in cooperation with peace-loving people everywhere, to work to transform the promise of space into a brighter tomorrow for all mankind.

Project Launched to Find New Planetary Systems

NASA and the University of Arizona, Tucson, have signed a memorandum of understanding to formulate a program for the detection and study of planetary systems around other stars.

NASA's Ames Research Center, Mountain View Calif., and the University have launched a joint project to study, plan and, if approved by Congress, develop an orbiting Astrometric Telescope Facility to be mounted on the agency's planned Space Station sometime in the mid 1990s.

The memorandum signed by William F. Ballhaus Jr., Director of the Ames Research Center, and Henry Koffler, President of the University of Arizona, cited "the development and operation of a Space Station-attached Astrometric Telescope Facility" as a principal objective of the joint program. It will be coordinated with other joint efforts aimed at the detection and detailed study of planetary systems, including development of photometric and spectroscopic techniques and theroretical modeling of planetary system formation.

"Astrometric telescopes are used to measure, with extraordinary precision, the positions of stars and other celestial objects against the sky," said Eugene H. Levy, Director of the University of Arizona's Lunar and Planetary Laboratory and head of its Planetary Sciences Department.

Levy and David C. Black, head of Ames' Planetary Detection Project, will be principal scientists in the collaborative project between Ames' Space Sciences Division and the University's Lunar and Planetary Laboratory.

Black described the project as "the beginning of a new scientific discipline. The results of the search, whether positive or negative, will profoundly alter our view of the universe." Until other planetary systems are found and studied, the principal project researchers say that theoretical models developed to explain the origin of our own solar system, or the formation of stars, cannot be fully tested.

The gravitational pull of planets orbiting around a star causes the star to wobble back and forth as seen against the sky. By measuring this wobble, an astrometric telescope can determine the presence of planets and even determine the properties of such a planetary system. The wobble-measuring technique is commonly used by ground-based telescopes to measure the properties of double stars in orbit around one another. However, to measure the disturbance in a star's motion caused by objects as small as planets, and to study the systems in detail, more precise measurements are required than can be achieved from telescopes on the ground.

For more than a decade, Lunar and Planetary Laboratory scientists have been developing spectroscopic techniques and instruments for the discovery of other planetary systems.

Although NASA and the University will work together on the entire project, Ames will coordinate the first two phases — system definition and implementation — and the University will coordinate the two final phases — the facility operation and scientific program.

While initial study and definition work will begin soon, ultimate implementation of the project will require that NASA obtain Congressional approval and funding several years from now.

Phase one will clarify the final design of the telescope

and how it is to be mounted on the Space Station.

Phase two will build the telescope and its instrumentation as well as mount it on the Space Station.

Phase three will establish the operating facilities on the ground.

Phase four will include the continuing scientific investigations, which will extend more than a decade. The scientists want the project to include a core program of planet detection and study, along with a program of guest investigations to make use of the unique capabilities of the telescope for astrometric studies of other important celestial objects.

According to the terms of the agreement, the Solar System Exploration Division of the Office of Space Science and Applications, NASA Headquarters, Washington, D.C., will assume overall responsibility for the four-phase project.

Satellite Search and Rescue System Saves Race Driver

A young Belgian race driver owes his life to space age technology.

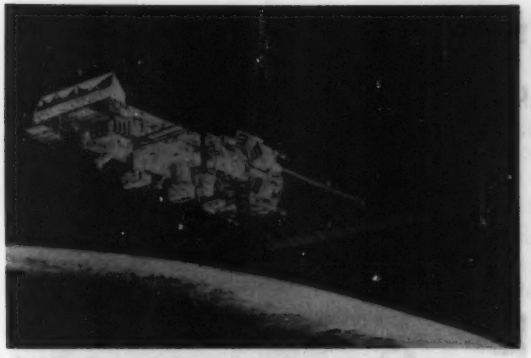
Serge Goriely, a 21-year-old driver, suffered a fractured skull when his four-wheel-drive Citroen crashed, rolled over several times and threw him out of the vehicle in a remote area of Somalia, Africa, where there were no communications or medical facilities.

A U.S. satellite — and later a Soviet satellite — picked up distress signals from an advanced, experimental radio beacon that was in the car. The signal was recorded first by the NOAA 9 weather satellite, launched Dec. 12, 1984, from Vandenberg Air Force Base, Calif. Later, the Soviet satellite, COSPAS 1, also picked up the signal.

The signal picked up by the American satellite was "dumped" (transmitted) to a National Oceanic and Atmospheric Administration (NOAA) ground station at Wallops Island, Va. The data then went to NOAA's facility in Suitland, Md., where it was analyzed and forwarded to the Air Force Mission Control Center at Scott Air Force Base, Ill.

Air Force personnel notified search and rescue authorities in Toulouse, France, and they informed French diplomats in Africa. A doctor then was flown to the injured race driver.

Goriely was taken to a military hospital in Djibouti, where he was treated for two days and then flown to Brussels, Belgium (his home), by the French Air Force.



An artist's concept of NOAA-9, launched Dec. 12, 1984.

Since the program began in September 1982, more than 344 lives have been saved. In the past, however, the satellites have used the 121.5/243 MHz system. With that system, the satellite could pick up a distress signal from ground or water, but a ground station had to be within range so the signal could be retransmitted to search and rescue forces.

The Goriely rescue marks the first time the advanced and still experimental 406 MHz/NOAA 9 has accounted for saving a life.

With the 406 MHz system, which transmits more detailed information than the other system, the distress signal is recorded by the satellite, stored onboard and dumped when it is over a station. The new system allows worldwide coverage compared to regional coverage with the 121.5/243 system.

There are no ground receiving stations for distress signals in Africa, thus the signal was not transmitted from the satellite until its orbit took it over the next ground station, which was Wallops Island.

Goriely's car, in which he was accompanied by co-driver Philippe Raymakers, 24, of Antwerp, Belgium, crashed near Galcaio, Somalia, about 2:13 p.m. EST, on New Year's Eve. Raymakers activated the distress beacon, furnished by Electronique Aerospatiale of Paris, at 3 p.m. and the signal was picked up by NOAA 9 two minutes later. The signal was transmitted to the ground station and analyzed. The French in Toulouse were notified of the distress signal at 4:19 p.m. — just one hour and 19 minutes after the beacon had been activated. An hour later, the Toulouse station picked up a similar signal from the Soviet satellite.

Goriely, who remained in the Brussels hospital for a week, is now recovering at home and hopes to rejoin the race somewhere along the 35,000-mile course from Cape Town, South Africa, at the southernmost tip of Africa, to Tierra Del Fuego, Argentina, the southernmost point in South America.

Shuttle Mission 51-E — Pre-Launch Profile

Crew: Karol J. "Bo" Bobko, Commander
Donald E. Williams, Pilot
Margaret Rhea Seddon, Mission Specialist 1
Jeffrey A. Hoffman, Mission Specialist 2
S. David Griggs, Mission Specialist 3
Patrick Baudry, Payload Specialist
Sen. Jake Garn (R. Utah), Payload Specialist

Orbiter: Challenger (OV-099)

Launch Site: Kennedy Space Center, Fla., Pad 39A

Launch Date/Time: March 3, 1985; 8:30 a.m. EST*

Orbital Inclination: 28.45 degrees

Altitude: 153.5-157 nautical miles

Mission Duration: 4 days, 1 hour, 3 minutes*

Orbits: 64 full orbits; landing on 65th

Landing Date/Time: March 7, 1985; 9:33 a.m. EST*

Landing Site: Kennedy Space Center, Fla.

Payloads: TDRS-B (Tracking and Data Relay Satellite)
Telesat-I (Anik)

Mission Firsts: First French payload specialist
First Congressional payload specialist

Experiments: French Echocardiograph Experiment
French Postural Experiment

*Subject to change; mission elapsed times are approximate.

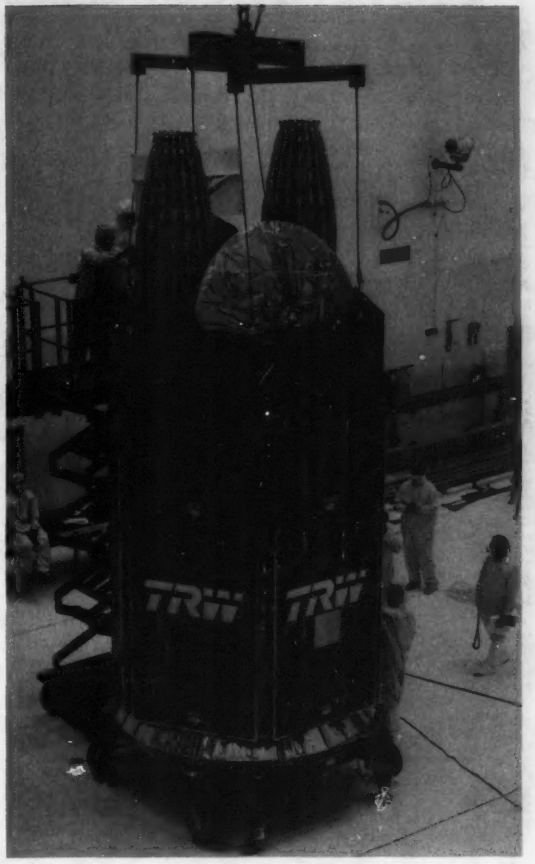
Principal Mission Activity

Tracking and Data Relay Satellite — TDRS-B will be the second spacecraft deployed for NASA's Tracking and Data Relay Satellite System. Two spacecraft (TDRS EAST over the Atlantic Ocean at 41 degrees west longitude and TDRS WEST over the Pacific Ocean at 171 degrees west longitude) will operate in the S-band and Ku-band frequencies and provide a high-capacity communication and data link with the Shuttle as well as other NASA spacecraft and launch vehicles. TDRS will be secured in the bay by a tilt table support structure which, upon command from the crew, will move the spacecraft to a 59-degree "pitch up" deploy attitude. Upon deploy command, spring-driven actuators in the tilt table provide the lateral thrust to move the spacecraft away from the Shuttle. The 5,000-pound TDRS will be placed in a synchronous equatorial orbit by a two-stage, three-axis stabilized Inertial Upper Stage (IUS). The White Sands Ground Terminal will then configure TDRS for on-orbit operations.

Telesat-I (Anik), a communications satellite owned by Telesat Canada Ltd., will be boosted to geosynchronous orbit by a PAM-D upper stage. This will be the fourth launch of a Telesat from the Space Shuttle. The first one was successfully deployed by the STS-5 crew in November 1982; the second was deployed in June 1983 on STS-7; and the third was deployed on STS 51-A in November 1984. The four spacecraft will provide voice communications and television coverage to a trans-Canadian satellite network.

The **French Echocardiograph Experiment** (FEE) will investigate the cardiovascular system's adaptation to microgravity. The FEE uses an ultrasonic scanning device to gather data on quantitative blood flow and location. The echocardiograph uses two double lockers. The first contains the electronics; the second holds the video tape recorder, the control monitor and a storage drawer. French payload specialist Patrick Baudry will participate as a test subject and assist in collecting data on crew-member Rhea Seddon.

The **French Postural Experiment** (FPE) is designed as a flight experiment to understand better the adaptation of postural control in a microgravity environment. Parametric measurements of electromyographic (EMG) activity of muscles, angular head movement and up-and-down eye movement will be conducted on a subject in the middeck. Measurements will be obtained using biochemical electronic sensors, data tape recorders and 16mm camera.



TDRS-B is prepared for mating to its Inertial Upper Stage in the Vertical Processing Facility.

Summary of Major Activities

Flight Day 1
Orbit insertion
TDRS-B deployment

Flight Day 2
Backup TDRS-B deploy opportunity
Telesat-I (Anik) deployment
French Echocardiograph Experiment activity

Flight Day 3
Backup Telesat-I deploy opportunity
French Echocardiograph Experiment activity

Flight Day 4
On-orbit crew press conference
Cabin stowage activities

Flight Day 5
Landing at KSC

Goddard Calls for Commercial Space Platform Proposals

Goddard Space Flight Center, Greenbelt, Md., has issued a Request for Proposal, asking industry to develop a space platform to provide five years of on-orbit services to NASA payloads and still allow the developer to market to a wide variety of commercial users.

In a departure from customary practices, industry would finance, develop, own and operate the platform. This innovative approach is considered a major "first step" toward creating a closer partnership between government and industry in space. Goddard officials described the action as a "pioneering effort that will allow many payloads from different users to share the same platform, with the first use in late 1988."

The platform — which is totally separate from NASA's plans for a government-developed permanent manned Space Station — the commercial entrepreneur would be free to market the platform services for materials processing or other manufacturing-type activities.

However, the government stipulates the plattorm must be capable of providing services for three of NASA's forthcoming projects — the Extreme Ultraviolet Explorer (EUVE), the X-Ray Timing Explorer (XTE) and a Zero Gravity Payload — as well as for a fourth, as yet unidentified project.

The EUVE will be a free flyer after its deployment from the Space Shuttle on a mission now scheduled for December 1988. Its primary objective will be to conduct a survey of the entire celestial sphere (full-sky) in the extreme ultraviolet. The science payload will weigh 1,600 lbs.

The XTE will explore X-ray sources to help scientists learn more about the physical laws governing their bahavior. The XTE payload will weigh 3,300 to 4,400 lb.

The Micro-Gravity Payload carrier will weigh 2,000 lb. and will be used to house microgravity experiments on orbit for up to six months. The contractor will be required to maintain the zero-gravity environment and to supply continuous power up to 2,000 watts.

As planned, the commercial platform would be launched into space from either the Shuttle or another launch vehicle. In one possible scenario, payloads launched in the Shuttle would be taken to the platform where the astronauts would remove the payload that had been aboard the platform, install another payload and bring the payload which previously had been on the platform back to Earth.

Priesthood is Final Frontier for Retired JSC Engineer

Former aerospace engineer Carl Amos, veteran of space flights spanning Mercury to the Space Shuttle, flights, doesn't "ooh" and "ahh" about a quarter-century career in space exploration.

"What was good about it was the people I worked with at NASA — quality individuals who worked well as a team," recalls Amos, "dedicated people who wanted to get the job done, not dash home in time to watch TV. The people made it exciting."

Today, he's just as matter-of-fact about his planned second career as a priest for the Diocese of Galveston-Houston. At age 60, he's as young in spirit as any of his fellow seminarians at Sacred Heart School of Theology in Hales Corners, Wis.

"That motorhome out in the school parking lot shows what my plans might have been," he says. "This priesthood thing came on pretty quick. But then, I'm used to a quick launch."

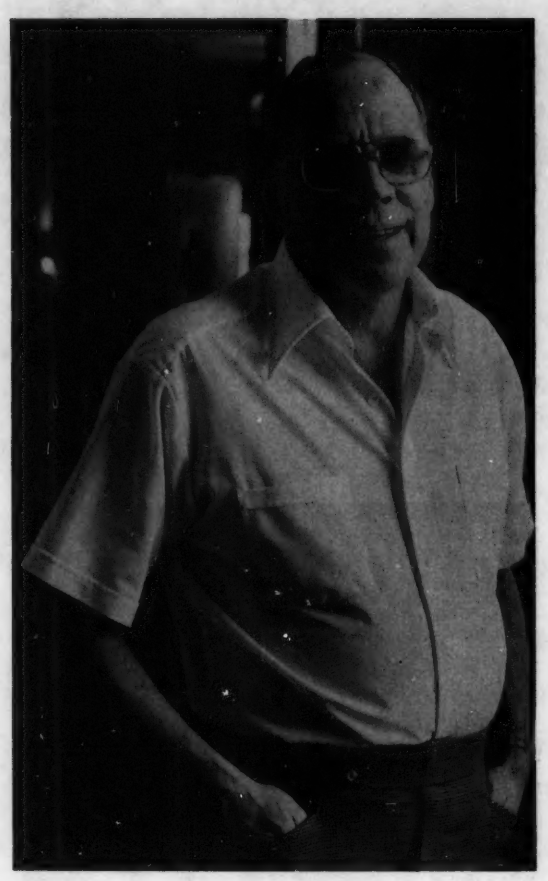
Born in Missoula, Mont., in 1924, Amos attended Catholic schools (except for a single year in high school) all the way through to his bachelor's degree from Gonzaga University in Spokane, Wash., in 1950. A tour of duty with the U.S. Navy included four war-time amphibious landings at places with familiar names — Guam, Leyte, Luzon and Okinawa.

Upon graduation from Gonzaga, while employed by the Philco Corp., he returned to the Philippines. He continued there with Philco and met his bride, Julita, in 1952. His 11 years in the Philippines proved a steppingstone to NASA aerospace, to which he moved upon the completion of John Glenn's historical three-orbit Mercury flight in 1962.

"With Mercury and Gemini I worked as a spacecraft systems engineer. On Apollo and the programs that followed, I worked mostly in the launch vehicle areas," said Amos. He settled down in the Houston area, except for five years in Utah, where he worked on solid-fuel rocket motors for the Space Shuttle program.

Upon retirement in 1981, he did some consulting work, but the "magic of the old days was gone."

The reasons for finally, *really* retiring were complex. In 1980 Julita died. "Except for that, my life was pretty terrific. All my jobs were interesting, exciting and challenging. I'd seen half of the world and I had earned a place — a small place — in history. But that's what it was — history — because space flights today are no longer exciting. For me, the feeling was gone, and a new one was moving in. My children, a girl and a boy, were grown and on their own. I knew, no matter what my decision, that they would support me."



Carl Amos

A vocation director in Salt Lake City heard him out on the subject of his calling to the priesthood, but worried it came too soon after his wife's death. Back in Houston, he found greater encouragement.

The Diocese of Galveston-Houston has enjoyed success with older candidates like Amos for the priesthood. Sacred Heart School, which specializes in preparing men of mature years and experience for the priesthood, has had half a dozen candidates from the Houston area over the years. Amos found encouragement from vocation directors Rev. Mario Arroyo and Sister Rosalie Ann Karstedt, CDP, and from the pastor of a parish near his home. Msgr. Francis Wearden of Deer Park, Texas.

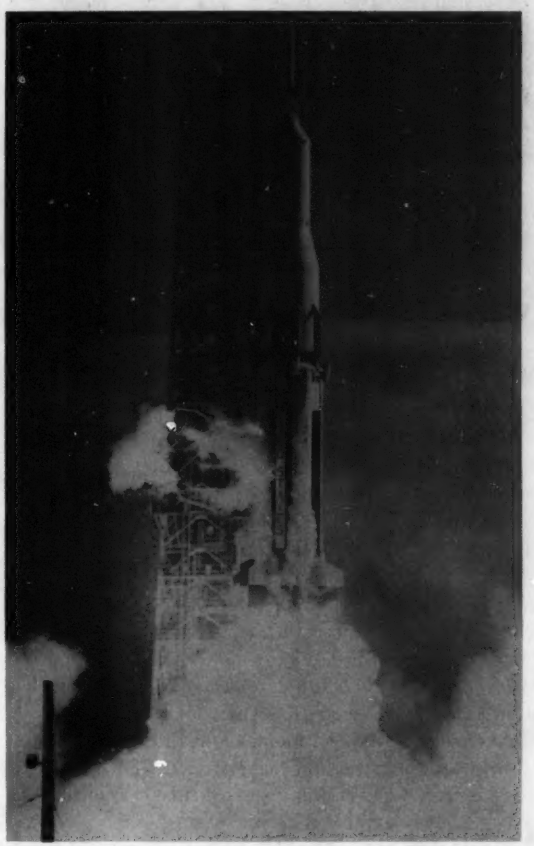
"I told them the Lord had given me a wonderful first career, and that, if I could, I would like to pay a little bit back. What I learned is that age alone isn't usually a factor," he said. "Sacred Heart and a few other schools had been doing pioneer work in vocations just as NASA

was in space shots. Within three months of approaching my vocation director, I was unpacking my motorhome in Hales Corners."

Amos' future probably involves parish work within an Hispanic community in the Galveston-Houston Diocese. He is now preparing himself for intensive Spanish-language work next year in Cuernavaca, Mexico.

What's special about Carl Amos is his readiness for change. It is a feature, says Sacred Heart School Rector Thomas J. Garvey, SCJ, which characterizes all of its graduates, no matter what their age.

In Amos' case, space prepared him for spirit. And he promises, all systems are "go."



Pegasus 20th Anniversary—Feb. 16 marks the 20th anniversary of Pegasus 1, the first active payload launched during the Saturn vehicle tests. Pegasus, a meteoroid detection satellite with winglike panels spanning 96 feet, collected data until Jan. 13, 1968. The spacecraft reentered Earth's atmosphere Sept. 17, 1978.

Blood Cell Experiment Carried on 51-C Flight

An experiment to investigate the effects of different diseases on red blood cell aggregation and blood viscosity was carried aboard Space Shuttle flight 51-C. The experiment was originally scheduled to be flown on mission 51-A in November 1984 but was withdrawn from the manifest due to orbiter weight and center of gravity considerations. The Department of Defense allowed NASA to add the experiment to 51-C, a dedicated DOD mission.

Called Aggregation of Red Blood Cells (ARC), the experiment was designed to provide information on the rate of formation (kinetics) and the internal structure and organization (morphology) of red cells, and on the thickness (viscosity) of whole blood at high and low flow rates.

Blood samples from both healthy donors and donors with different medical conditions, such as heart disease, hypertension, diabetes and cancer, were used. Results obtained in microgravity will be compared with results from a ground-based experiment to determine what effects gravity has on the kinetics and morphology of the blood. The ground-based experiment was conducted simultaneously with the flight experiment, using identical blood samples and functionally identical hardware.

The flight-hardware, weighing about 165 pounds, was installed in place of three middeck lockers in the Shuttle orbiter crew cabin. It consisted of an experiment apparatus container housing a blood pump/storage subsystem, parallel plate slit capillary viscometer, photo/optical subsystem, thermal control system, pressure transducer and an electronics equipment package to provide automated control and data acquisition.

The only crew involvement with the experiment was the flipping of a "process" switch to activate it sometime during the first 24 hours after launch. All other procedures were operated automatically through the electronics package. Running time was about eight hours.

Primary objective of the experiment was to determine whether information obtained in microgravity can be used in the formulation of new diagnostic tests or the improvement of existing tests for the benefit of clinical research and medical practice.

The experiment used eight blood samples stored in tubular syringes maintained at about 4 degrees C. Each syringe had a teflon-coated steel ball inside used to stir the blood prior to use. Stirring was accomplished by a motor-driven magnet which agitated the ball. A

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motorized plunger dispersed the blood at a pre-set flow rate through tubing and into a heater which raises the blood temperature to about 25 degrees C. The sample would then flow into the viscometer where a pressure transducer measured the actual flow rate. The viscometer consisted of two optically transparent polished glass plates separated by a spacer ofplatinum foil. Two 35mm cameras, located on either side ofthe viscometer, photographed the samples through 10- and 300-power microscopes. The 10-power microscope used black-and-white film; a 300-power used color. After the photographic and flow-rate data were obtained, the sample was discarded in a waste container. Saline solution, stored in syringes identical to those containing the blood samples, was then used to flush the system in preparation for the next sample.

The experiment and experiment hardware were developed by Dr. Leopold Dintenfass of the Kanematsu Institute (Department of Medical Research) in Sydney, Australia. Marshall Space Flight Center in Huntsville, Ala., has NASA responsibility for the flight of the experiment.

After landing, data from the flight experiment was turned over to Dr. Dintenfass for analysis and comparison with data from his ground-based experiment. There was no transfer of data from the flight experiment to the ground during the mission.

NASA, Rockwell Sign Agreement for Material Processing Laboratory

A memorandum of understanding signed by NASA and Rockwell International Corp., Downey, Calif., could provide future Shuttle flight assignments for on-orbit transport of the aerospace firm's uniquely designed materials processing laboratory.

Under the terms of the 180-day agreement, Rockwell will develop an industrial space processing program in which the company's modular, zero-gravity laboratory would be made available to research institutions and commercial firms for installation and operation of developmental experiments.

Experiment packages would involve a range of processing applications including liquid chemistry, fluid physics, thermodynamics, crystal growth and biological cell culturing.

Rockwell's laboratory — with an in-house company name of Fluids Experiment Apparatus (FEA) — is designed for placement in stowage areas of the Shuttle's middeck where it would be engaged and monitored by Shuttle crew members.

The zero-G laboratory, about the size of a 19-inch television set, is the first industrially developed laboratory to be made available to the scientific community and commercial firms permitting the proprietary pursuit of basic and product research in low-Earth orbit.

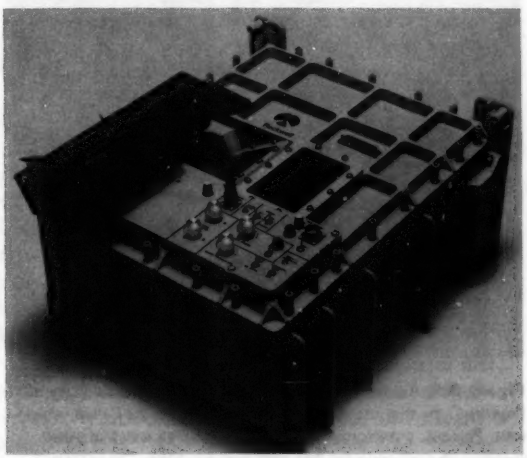
The FEA was successfully flown and operated in space last summer on Shuttle mission 41-D (Aug. 30 to Sept. 5, 1984) when, using the float zone technique, a single indium crystal was grown with a lattice structure originating from a crystal seed.

The space processing laboratory, designed at the company's Space Transportation Systems Division in Downey, has the functional capability to heat, cool, expose to vacuum and manipulate experiment samples which may be gaseous, liquid or solid.

Samples can be mixed and stirred in containers or be processed semicontainerless in the float zone mode. Samples may be removed and changed during a mission and a motion picture or video camera may be installed to record samples' behavior and instrumentation data displays.

The zero-G laboratory has interior dimensions of 18.6 by 14.5 by 7.4 inches and can carry 11 pounds of experiment hardware. The modular design permits easy configration for almost all experiments. Optional subsystems include fluid manipulation containers, bulk fluid chemistry chambers, living cell incubators and multisample columns.

The agreement was signed by Isaac T. Gillam IV, NASA's Assistant Administrator for Commercial Programs, and Dr. Rocco A. Petrone, President of Rockwell's Space Transportation Systems Division.



Rockwell's Zero-G Laboratory.

ESP Catches on at Marshall

Participation in ESP (Employee Suggestion Program) has caught on at NASA's Marshall Space Flight Center in Huntsville, Ala. In fiscal year 1984, suggestions submitted increased 120 percent over 1983.

Not only are employees offering more suggestions, but management's adoption of ideas increased by 90 percent from 1983 to 1984. As a result, Marshall employees received 54 percent more in cash awards, and tangible savings to the government increased by 270 percent.

One cost-saving idea was submitted by Jerald D. Oakley, an electronics technician in Marshall's Test Laboratory. Oakley recognized the need to control internal pressure and loads to meet unique hydraulic loading requirements during filament-wound motor case structural tests. A backup system was necessary in case technical problems with the primary system developed. Oakley developed the required system using components of in-house instrumentation and equipment. His ingenuity produced first-year savings of more than $80,000 and earned him a $2,750 cash award.

Another idea, involving the cooperation of two center organizational elements, was submitted by Michael C. Clemons, a systems accountant in the center's Comptroller Office. His suggestion eliminated the duplicate keytaping of Fedstrip/Milstrip receiving reports, reducing data entry, computer time and processing time by the General Accounting Division in the Comptroller's Office. The modification, requiring the addition of one digit by the Property Management Division in the Management Operations Office, resulted in first-year savings of more than $7,000. Clemons received a $550 cash award.

Dr. Mary Helen Johnston, a materials engineer in the Materials and Processes Laboratory, and Robert B. Owen, a physicist in the Space Science Laboratory, suggested a new method of monitoring crystal growth in the fluids experiments system during the Spacelab 3 mission. Implemented in February 1984, the idea resulted in intangible savings, garnering Johnston and Owen a shared cash award of $750.

The above examples of increased employee involvement did not happen by accident. Significant management support and attention to ESP have created an environment for ideas to grow.

Center director Dr. William R. Lucas reminded Marshall supervisors that "one of the greatest potential sources that exists for effecting improvements in operations is through ideas generated by our employees." Support of ESP has been generated by

Jerald B. Oakley (left) receives suggestion award from Dr. William R. Lucas, director of Marshall.

funneling all suggestions through major organization heads, emphasizing the program in supervisory orientation and training, and publicizing successful ideas. Timely and thorough evaluation of employees' ideas has further boosted the program effort.

Enterprise Popular Attraction at World's Fair

NASA's Space Pavilion, featuring the orbiter Enterprise and other exhibits, was one of the most popular attractions at the Louisiana World Exposition in New Orleans from May 12 through Nov. 12.

Located on the New Orleans waterfront, the Enterprise was placed on a four-foot-high display pad between the United States and International Pavilions. Visitors were able to approach close enough to stand under the tips of the orbiter's wings. Recorded information on the Space Shuttle was available nearby in six languages.

About 100 yards away in the International Pavilion was the NASA Space Pavilion, where visitors were informed about the latest in the nation's space activities.

More than 2.5 million fair visitors entered the Space Pavilion to see exhibits on the Space Shuttle, Space Station and a full-scale mock-up of the Spacelab and a Shuttle orbiter flight deck. Visitors were treated to audio-visual productions — addressing NASA activities in the fields of space science, commercial uses of space and aeronautics — displayed on video kiosks throughout the pavilion. One video production presented information on NASA Visitor Centers located across the United States.

The highlight of the Space Pavilion was a video production, projected overhead on three large screens, that dealt with Space Shuttle launch and landing

operations, and living and working in space. In addition, live Shuttle video was provided by an antenna receiver unit located outsided the pavilion.

As part of National Spaceweek activities (July 16-25), July 20 was proclaimed Space Day at the fair. Special video presentations of the Apollo 11 missions were shown inside the Space Pavilion, and, at a special press conference held in front of Enterprise, Apollo 11 astronauts Neil Armstrong, Buzz Aldrin and Michael Collins were reunited on the 15th anniversary of their historical flight.

Orbiter Enterprise as seen by more than 6 million visitors to the Louisiana World Exposition.

What's New in NASA Radio Programming

Programs released in January:

Space Story (4½-minute programs):

"Detecting Planets Around Stars" (featuring Dr. Dave Black, Ames Research Center)

"Upper Atmosphere Research Satellite" (featuring Dr. Carl Reber, Goddard Space Flight Center)

"Penetrating Venus' Sizzling Atmosphere" (featuring Dr. Geoffrey Briggs, NASA Headquarters)

"The Space Telescope" (featuring Dr. Edward Weiler, NASA Headquarters)

Special Report (14½-minute program):

"Let's Take A Walk Through the Universe With the Space Telescope" (featuring Dr. Edward Weiler, NASA Headquarters)

NASA's radio programs are sent to approximately 3,500 radio stations across the nation; in addition, translations of the recordings are made by Voice of America and Radio Free Europe and these tapes are then released to the appropriate audiences overseas. Released each month are one report of 14½ minutes and four 4½-minute weekly stories (one story in the set is featured for one week of the month). Ten one-minute space notes are released quarterly.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces the following U.S. patents have been issued by the U.S. Patent Office and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Charles J. Camarda, Lana M. Couch, NASA/LaRC	Heat pipe cooled probe	4,485,670	LaRC
David D. Kershner, NASA/LaRC	Miniature electro-optical air flow sensor	4,485,671	LaRC
Dhanvada M. Rao, Old Dominion University Research Foundation, Norfolk, Va.	Leading edge flap system for aircraft control augmentation	4,485,992	LaRC
Chialin Wu, Caltech/JPL, Pasadena, Calif.	Method and apparatus for self-calibration and phasing of array antenna	4,488,155	NRO-JPL
Robert L. Fox, Bruce D. Little, Robert H. Coultrip, Alan W. Frizzill, Donal J. Progar, Richard H. Couch, John R. Gleason, John D. Buckley, Bland A. Stein, Terry L. St. Clair, NASA/LaRC	Hot melt adhesive attachment pad	4,488,335	LaRC
William B. Grant, E. David Hinkley Jr., Caltech/JPL, Pasadena, Calif.	Portable laser remote system for methane gas detection	4,489,230	NRO-JPL
Richard W. Dabney, NASA/MSFC	Power control for AC motor	4,489,264	MSFC

1985 Launch Activity

Space Shuttle Launches

Date	Mission	Orbiter	Launch Site*	Remarks
Jan. 24	51-C	Discovery (OV-103)	KSC	Dedicated Department of Defense flight; successful launch; KSC landing Jan. 27.
March 3	51-E	Challenger (OV-099)	KSC	Payload: Telesat-I, TDRS-B.
March 19	51-D	Discovery (OV-103)	KSC	Payload: Syncom IV-3; LDEF-1 retrieval mission.
April 30	51-B	Challenger (OV-099)	KSC	Payload: Spacelab 3.
May 30	51-G	Discovery (OV-103)	KSC	Payload: Spartan-I, Telstar 3-D, Morelos-A, Arabsat-A.
July 9	51-F	Challenger (OV-099)	KSC	Spacelab 2.

Satellite Deployments from the Shuttle

Date	Satellite	Upper Stage**	Shuttle Mission	Remarks
March 3	TDRS-B	IUS/2	51-E	NASA communications.
March 4	Telesat-I	PAM-D	51-E	Canadian communications.
March 20	Syncom IV-3	UUS	51-D	Hughes communications.
May 30	Morelos-A	PAM-D	51-G	Mexican communications.
May 31	Arabsat-A	PAM-D	51-G	Saudi Arabian communications.
June 1	Telestar 3-D	PAM-D	51-G	AT&T communications.

Expendable Launches

Date	Mission	Launch Vehicle	Launch Site*	Remarks
March 7	Intelsat VA-F10	Atlas Centaur	ESMC	Intelsat communications.
1st Qtr.	AF-16	Scout	WFF	U.S. Air Force.
1st Qtr.	Navy-22	Scout	WSMC	U.S. Navy.
April	Intelsat VA-C	Atlas Centaur	ESMC	Intelsat communications.
2nd Qtr.	Navy-23	Scout	WSMC	U.S. Navy.
August	Intelsat VA-D	Atlas Centaur	WSMC	Intelsat communications.
August	NOAA-G	Atlas	WSMC	National Oceanic and Atmospheric Administration weather satellite.
3rd Qtr.	AF-17	Scout	WFF	U.S. Air Force.
October	GOES-G	Delta	ESMC	NOAA environmental satellite.
December	San Marco	Scout	SMR	NASA cooperative with Italy.
4th Qtr.	AF-18	Scout	WFF	U.S. Air Force.
4th Qtr.	FLTSATCOM	Atlas Centaur	ESMC	U.S. Navy-U.S. Air Force Fleet Satellite Communications.

* **Launch Sites:** KSC — Kennedy Space Center, Fla.; ESMC — Eastern Space and Missile Center, Fla.; SMR — San Marco Range, Indian Ocean; WSMC — Western Space and Missile Center, Vandenberg Air Force, Calif.; WFF — Wallops Flight Facility, Wallops Island, VA.

** **Upper Stages:** IUS — Inertial Upper Stage; PAM-D — Payload Assist Module; UUS — Unique Upper Stage.

Another Dividend from Air and Space

NASA
National Aeronautics and Space Administration

Research and development in aeronautics and space have provided numerous benefits for all Americans — and at a tiny percentage of the tax dollar. Here is an example:

Ingestible Toothpaste

Toothpaste is not something one readily associates with the space program but it was one of the myriad considerations of putting man into space. Back in the 1960s, manned spacecraft were small and cramped, every available inch packed with mission-related equipment. It was impractical to include facilities for brushing teeth in the normal fashion, for example, a lavatory basin for expectorating and a system for handling the expectorated waste in zero-gravity environment. Planning for long-duration flights, NASA became concerned about astronauts' oral hygiene and sought an answer.

It was supplied by Dr. Ira L. Shannon, a dental consultant to Johnson Space Center associated with the oral Disease Research Laboratory of the Veterans Administration Hospital in Houston. Under NASA contract, Dr. Shannon developed a new type of toothpaste that is foamless and can be swallowed after use. Comparison tests with a commercially available dentifrice showed that there was no significant difference in the cleaning ability and user acceptance of the two types of toothpaste. Applied without water, the pleasantly-flavored ingestible toothpaste has been used for years by astronauts in space and on Earth, in some instances even by their families. Last year it was introduced to the commercial market by Scherer Laboratories, Inc., Dallas, as NASAdent.

The dentifrice is by no means a fad product; it is an important aid to maintaining oral hygiene among patients in hospitals, nursing homes and other special care facilities. A prime advantage is the fact that NASAdent's formulation eliminates the possibility of choking on air bubbles, a problem among total nursing care patients. It also offers major benefits to certain categories of patients, such as those bed-confined in hospital wards who might not have facilities for expectoration; paraplegics confined to wheelchairs; patients with oral-facial paralysis whose ability to expectorate is limited; the mentally handicapped; and others whose illness require that attendants carry out the teethbrushing for them. Scherer Laboratories suggests that NASAdent is also useful as a first toothpaste for children because of its ingestibility and lack of foam.

* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.